Neutron irradiated prototype CBM-STS microstrip sensors tested for double metal or cable interconnections of the end strips*

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The Silicon Tracking System (STS), the core detector of the CBM experiment, is located in the dipole magnet to provide track reconstruction and momentum determination of charged particles from beam-target interactions. The STS will have double-sided silicon microstrip sensors mounted onto a low-mass carbon fibre support structure. The strips on one side of the double sided silicon microstrip sensors are tilted to have 7.5^0 stereo angle. This allows to reconstruct multiple hits from the same sensor at the expense of a poorer spatial resolution in vertical direction [1]. To have read out only from one sensor side, the end strips from one edge of the sensor were connected to the end strips on the other end as shown in Fig. 1. This interconnection can be provided via double metallization (DM) or by using external interstrip cables (SMwC). However, the central strips were the full strips without any kind of interconnections (region II in Fig. 1).
Test results of these prototype sensors before and after their exposure to neutron equivalent fluences of 2×10^{14} $n_{eq}cm^{-2}$, as they are expected for the worst case scenario in the CBM experiment, will be disucssed. The sensors were irradiated at Karlsruhe Institute of Technology (KIT), Germany.

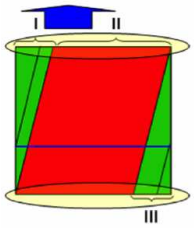

Figure 1: Sensor topology to read out inclined sensor strips.

All the measurements were performed in a refrigrator at temperatures between -5^0 C to -10^0 C to limit the radiation-induced effects on detector current and to prevent thermal runaway [2]. Four sensors were selected for the measurement of variation of leakage current with bias voltage (IV), bulk capacitance versus bias voltage (CV), and for charge collection tests for the central strips (region II in Fig. 1) and for the end strips (with these special interconnection scheme, region I in Fig. 1) with a ^{90}Sr source. In this report only the results from central strips will be discussed. The list of the sensors under test is given in Table 1 along with their sizes, thickness, types of the connections and full depletion voltage before irradiations (extracted from the capacitance-voltage measurements). These sensors were mounted in the printed circuit boards and were wire bonded to read out about 10 strips for each sensor side using self-triggered n-XYTER chip.

Table 1: Specifications for the sensors under tests. The naming convention in the left column encodes the prototype generation (5 or 6), the manufacturer (H = Hamamatsu, C = CiS), the sensor height/strip length in cm (4 or 6), and the wafer number.

name CBM0-	size cm × cm	thickness μm	inter-connection	V_{fd} ±5 V
5H4-W18	6 × 4	327	SMwC	68
5H4-W10	6 × 4	331	DM	75
6C6-W14	6 × 6	293	SMwC	94
5C6-W6	6 × 6	291	DM	98

Charge collection studies were performed with ^{90}Sr for the sensors under test by applying suffieciently high reverse bias. Results are shown in Fig. 2 for all the sensors with either double metal interconnection scheme or single metal with external microcable bonded on its top p-side. As can be seen in Fig. 2, the charge collection efficiency degrades after the irradiations. These sensors were also tested in-beam at COSY, Research Center Jülich, in December 2014. Before concluding on the type of the p-strip interconnection scheme, one should also consider the beamtime results about charge collection and detection efficiency of these sensors. This work is still in progress.

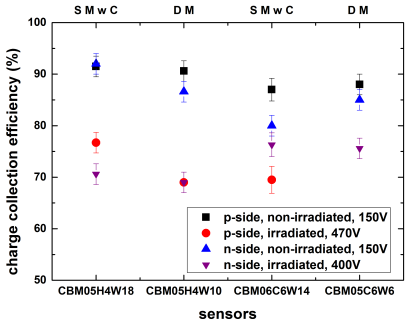

Figure 2: Charge collection results with ^{90}Sr, comparing the sensors before and after irradiation.

References

[1] J. Heuser et al., Technical Design Report for the CBM Silicon Tracking System, GSI Report 2013-4

[2] M. Moll et al., *Nucl. Instrum. Methods. A* 439 (2000), p. 282

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